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A new species of *Leptogorgia* from the eastern Pacific (Coelenterata: Octocorallia: Holaxonia)

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Abstract.—*Leptogorgia styx*, a new species of the holaxonian family Gorgoniidae from the eastern Pacific inhabiting waters unusually deep for this genus is described and illustrated. Scanning electron micrographs of sclerites and morphology of axial mineral are presented.

Family Gorgoniidae
Genus *Leptogorgia* Milne Edwards & Haime, 1857

Leptogorgia Milne Edwards & Haime, 1857:163 (type species *Gorgonia viminalis* Pallas, 1766, by subsequent designation: Verrill, 1869:420).
Lophogorgia Milne Edwards & Haime, 1857:167 (type species *Gorgonia palma* Pallas, 1766, by monotypy).
Filigorgia Stiasny, 1937:307 (type species *Filigorgia riodouroi* Stiasny, 1937, by monotypy).
Leptogorgia.—Grasshoff, 1988:97 (synonymy); 1992:54.—Williams, 1992:231 (synonymy).—Williams & Lindo, 1997: 500 (synonymy).

Remarks.—The genera *Leptogorgia* and *Lophogorgia*, long distinguished upon unreliable characters, were unequivocally united by Grasshoff (1988:97).

Leptogorgia styx, new species
Figs. 1–5

Material.—East Pacific Rise, approx. 500 km SSW of Acapulco, Mexico. Seamount 6: 12°43′12″N, 102°36′W, 1900–1950 m, R/V *Atlantis II* Dive AD3016, coll. Scott France and Ewann Berntson, 4 Nov 1996. Holotype USNM 98800.

Description.—The holotype (Fig. 1) is a broadly flabellate white colony 12.5 cm in height and 15 cm in greatest width, arising from a laminar holdfast covered with coenenchyme devoid of polyps, spreading over solid substrate; three primary trunks produce secondary branches in an irregular, openly pinnate sequence mostly in one plane. The main trunks are 3.5 mm in diameter, the terminal twigs 1.5 to 1.75 mm. Unbranched final twigs are blunt, mostly 2.25 cm or less in length, arising at a wide angle but soon curving upward roughly parallel with the larger branches. Polyps are distributed on all sides, fully retractile into the coenenchyme, which is not elevated around the apertures. A narrow, sinuous groove extending along two sides of the main stems marks the course of the primary stem canals.

Sclerites (Fig. 2) of the coenenchyme are colorless and of the usual gorgoniid design. The longer ones are tuberculate spindles up to 0.15 mm in length, some of them slightly curved (Fig. 2a), the shorter ones blunt tuberculate capstans 0.05–0.08 mm long with two whorls of complex tubercles and terminal clusters (Fig. 2b); the sclerites of the innermost coenenchyme are small rods 0.05–0.08 mm long, with conical, less complex tubercles (Fig. 2c). As usual, a small number of crosses are present, and intergrades in size and form are numerous. The anthocodiae contain narrow, somewhat flat-

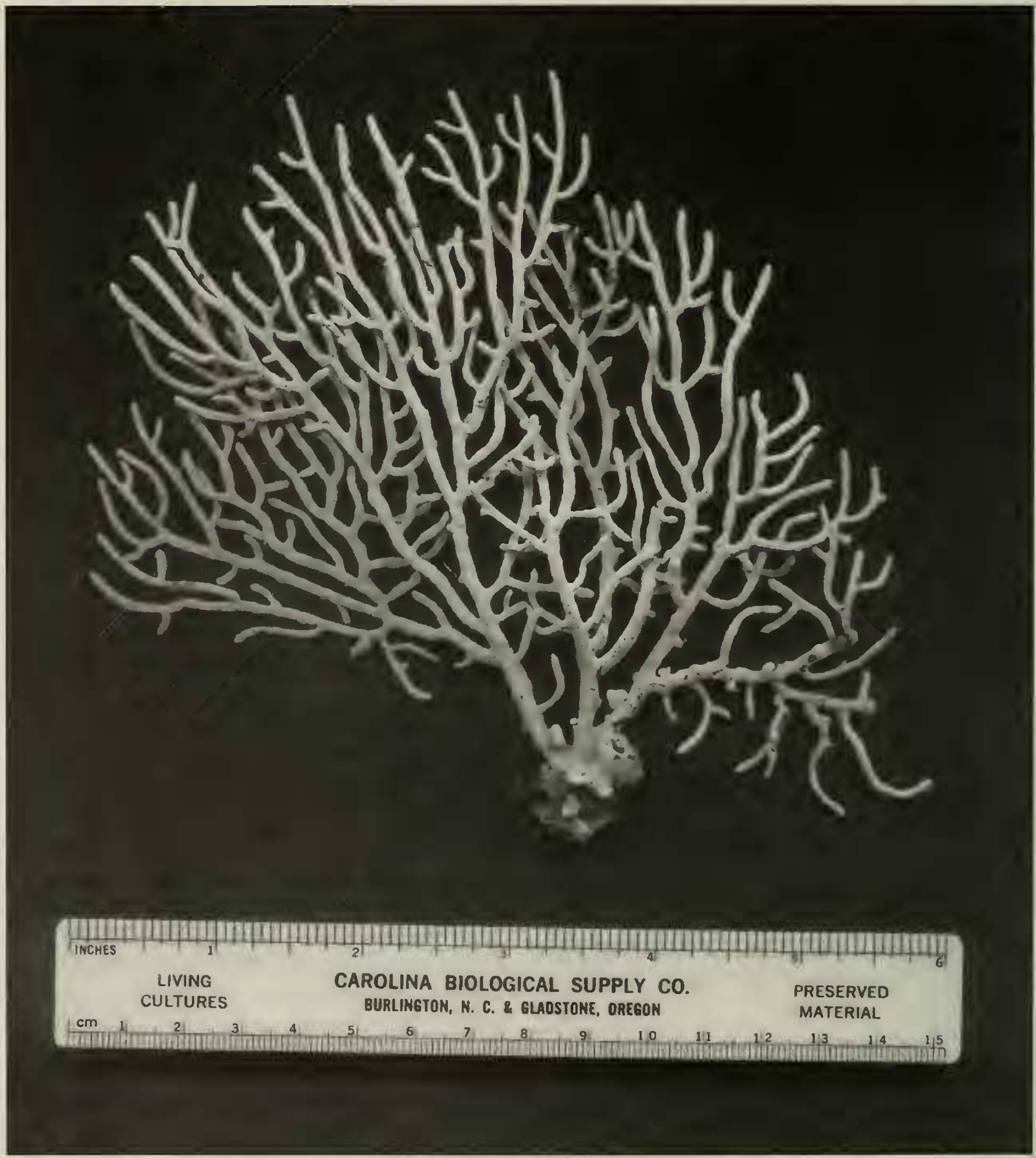

Fig. 1. *Leptogorgia styx*, new species. Holotype colony, USNM 98800.

tened rods, smooth except for a very few marginal projections; dissection of several polyps did not reveal their arrangement and, owing to their relatively small numbers in the preparations, no examples could be found for examination by SEM.

The axis of the terminal branchlets is pale yellow, glassy clear with a clearly visible narrow white chambered central core, becoming dark brown, almost black, in the larger branches and main trunks; it is marked by irregularly sinuous longitudinal ridges and grooves. The axis effervesces briskly in HCl, indicating dense mineralization.

When exposed by free-hand longitudinal section, the chambers of the core are filled with extremely fine organic filaments, sim-

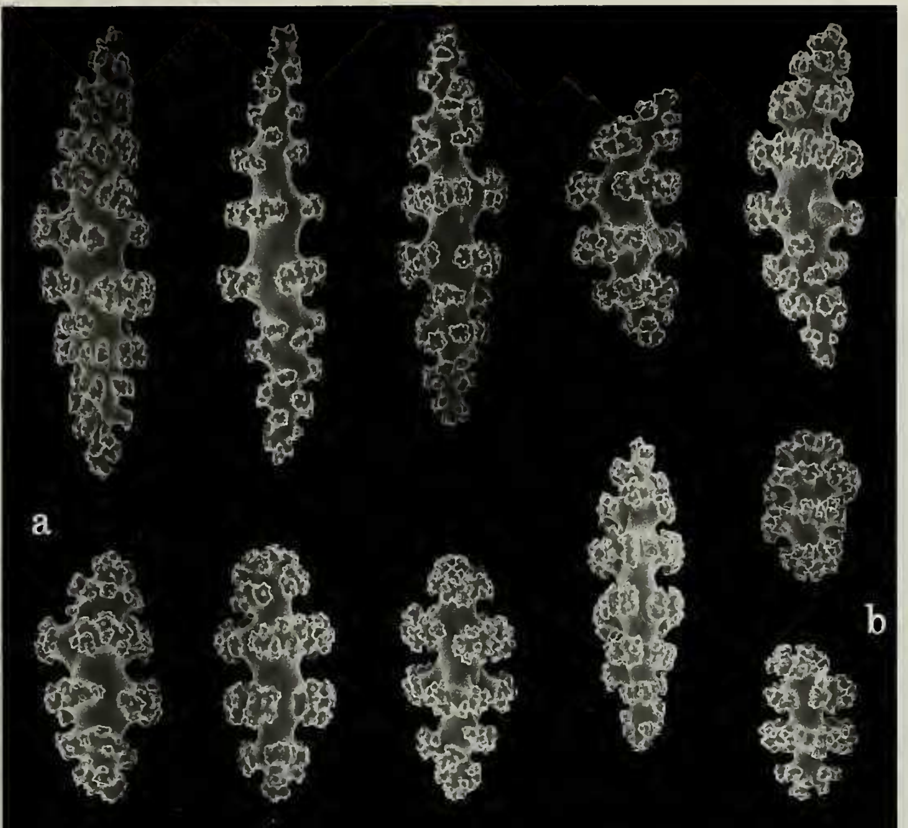

Fig. 2. *Leptogorgia styx*, new species. Sclerites of coenenchyme and axis of terminal twig. a, Tuberculate spindles; b, Blunt capstans; c, Rods of innermost coenenchyme, with cruciform present in all layers; d, Axis of terminal twig after maceration in sodium hypochlorite. (SEM 2837.)

ilar to those first reported in the central core and axial loculi of various gorgonians by Kölliker (1865:150, 151) and later in the central core ("Achsenstrang," "Zentralstrang") of *Eunicella verrucosa* by Koch (1878) and of *Pterogorgia pinnata* and several other holaxonians by Neuman (1911: 505. "das Innere jeder Kammer von einem äußerst dichten Netzwerk feinster Fäserchen durchzogen wird.") and Schimbke (1915:74. "ein feinstes Hornnetz"), and of *Pseudoplexaura crassa* by Chester (1913: 742, "chambers filled with loosely branching threads").

The core is surrounded by successive layers of axial cortex (= "sheath" in Macintyre et al. 2000) composed of longitudinally aligned strands of mineralized gorgonin (Fig. 3, top).

After removal of the organic matrix by maceration in 5.25% sodium hypochlorite solution (18 hr), the mineral component of the axis becomes colorless, translucent but faintly cloudy when wet, the opaque core still clearly visible; after washing and drying, it becomes opaque white.

Although the mineral component of the axis of the western Atlantic *Leptogorgia virgulata* has been interpreted as amorphous calcium carbonate (Kingsley & Watabe 1982), Macintyre et al. (2000) have determined that the axial mineral of that species as well as that of the one here described consists of carbonate hydroxylapatite (hereafter abbreviated CHAp) rather than amorphous $CaCO_3$.

The filaments of this network are coated with CHAp initially deposited in the form of submicron spheres that sometimes fuse together to form a continuous rodlike coating that retains an indication of the original spherulitic construction (Fig. 4). The individual spheres are up to 0.65 μm in diameter, the columnar mineralized filaments up to about 1.2 μm in diameter.

The CHAp comprising the mineral component of the axial cortex forms the crenulated sheaths around the axial core as reported in Macintyre et al. (2000). The component crystallites are too fine for resolution in the available SEM and do not form submicron spheres as in the chambers of the core.

The holdfast extending over the substrate a short distance beyond the main trunk is a fibrous, dark brown to almost black, lamellar expansion consisting of numerous thin layers of gorgonin with intervening locular spaces, covered by coenenchyme devoid of polyps. The locular spaces between the lamellae are filled with fine organic filaments like those of the central core (Fig. 3, bottom).

After the gorgonin matrix of the holdfast is removed by maceration in sodium hypochlorite, the mineral component consists of a white particulate residue including fragments of the much broken mineralized lining of the loculi. The mineral coating the locular walls is composed of CHAp deposited in the form of submicron spheres up to about 0.6 μm in diameter, many of which give rise to rodlike filaments 0.6 μm–0.9 μm in diameter composed of fused spheres and showing clear evidence of deposition in layers (Fig. 5, lower right).

The crystallites comprising the CHAp component of the axis and holdfast of this and other species of *Leptogorgia* are so fine that analysis by X-ray diffraction has not revealed an indication of apatite except in two species, *Leptogorgia stheno* and *L. setacea*, and not in all specimens of those. Morphology of the submicron spheres examined by SEM indicates that the mineral is precipitated initially as a minute spherule at a nucleation site on an organic filament, increasing in size and girdling the filament until meeting on the opposite side (Fig. 5, upper and lower left), often enlarging until all evidence of the point of contact has been overgrown and obliterated. The surface of fully grown spheres and fracture surfaces of the mineral where breaks have occurred during preparation indicate that the CHAp in this species is precipitated in even finer microsphrulitic form (Fig. 5, upper and lower left).

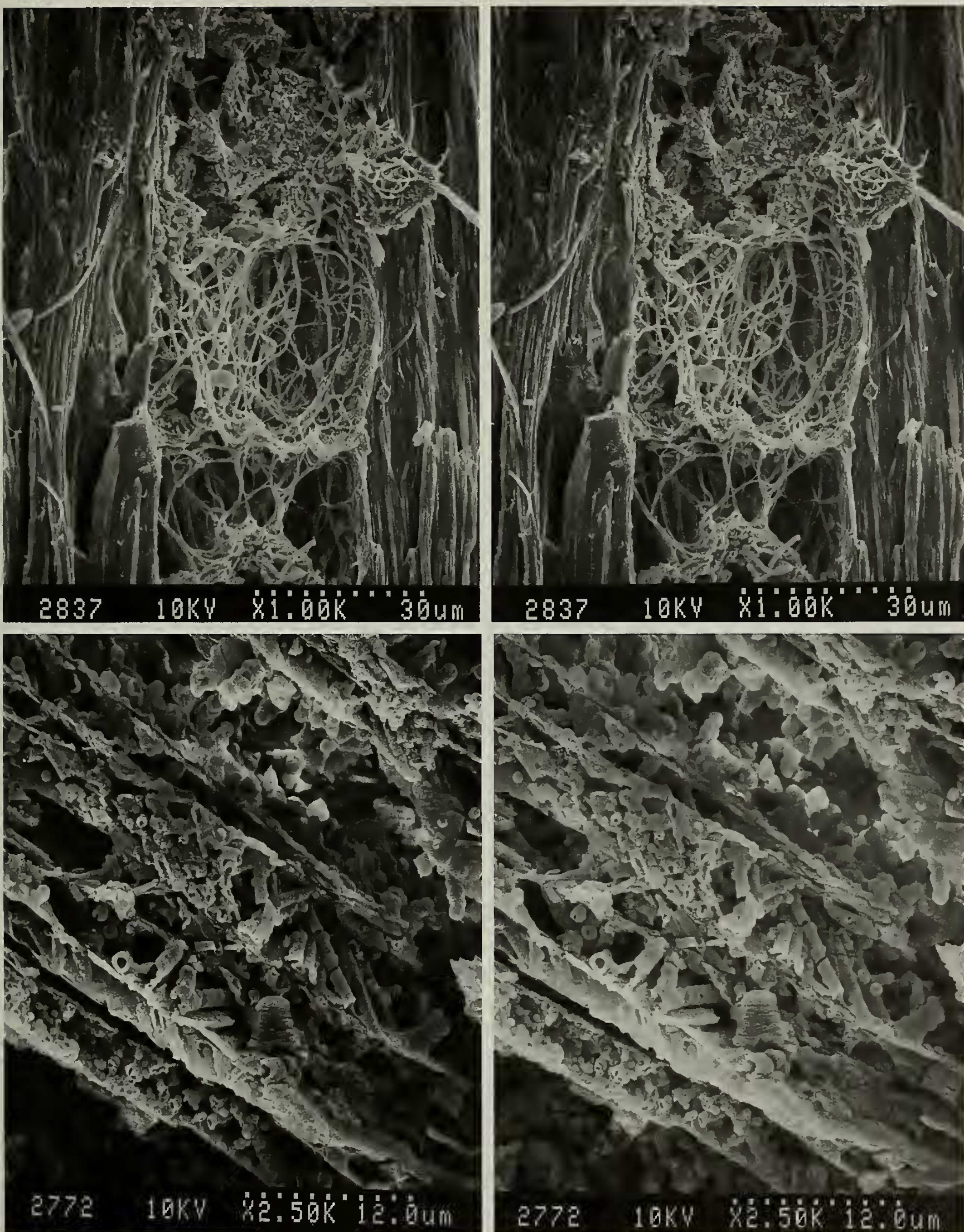

Fig. 3. *Leptogorgia styx*, new species. Structure of axis not macerated in sodium hypochlorite: Top, Longitudinal section of axis showing chambers of core filled with mineralized filaments (SEM 2837, stereo pair); Bottom, Loculi of holdfast showing mineralized filaments (SEM 2772, stereo pair).

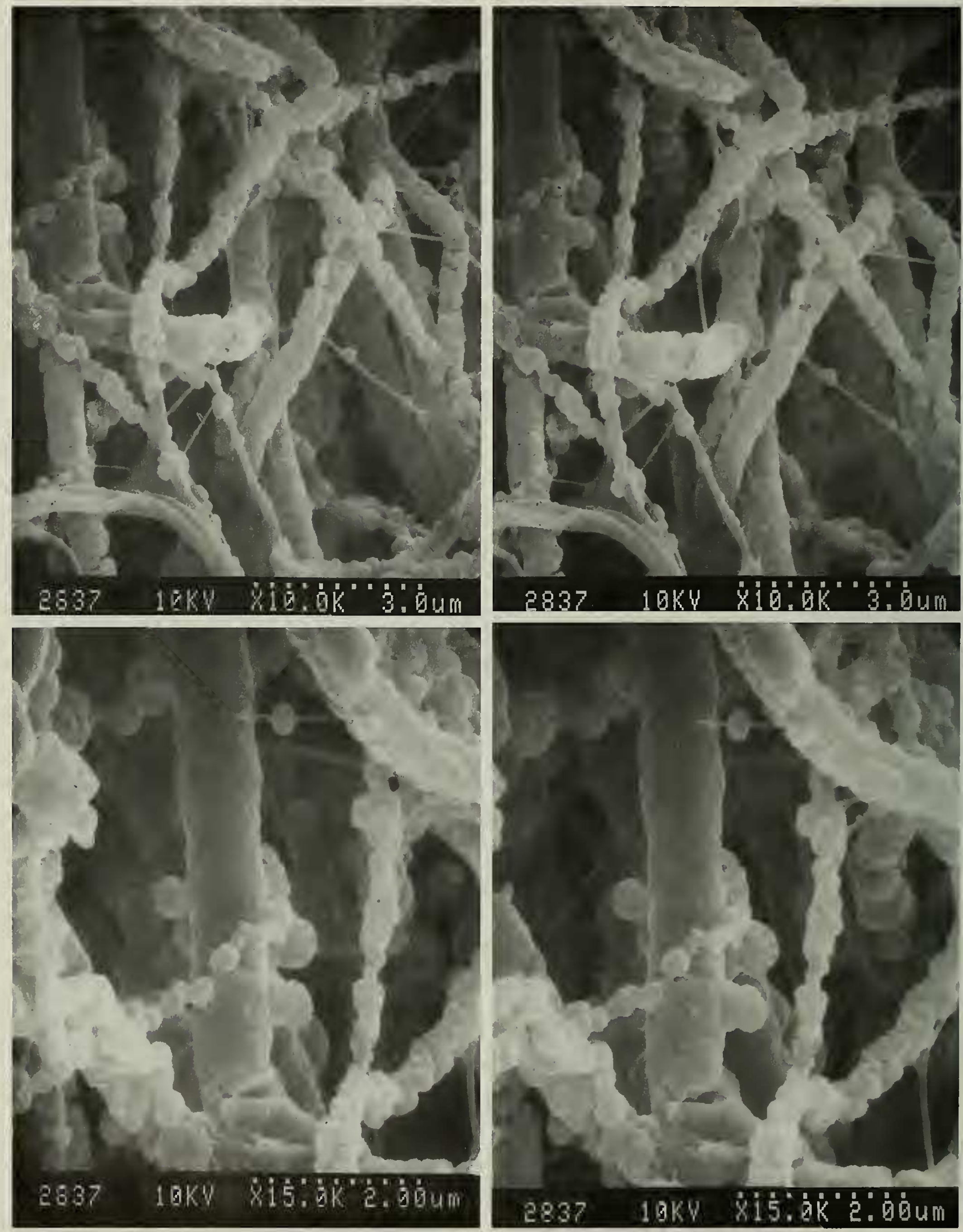

Fig. 4. *Leptogorgia styx*, new species. Mineralized filaments of axial core (SEM 2837, stereo pairs).

Etymology.—Greek *Styx*, the mythical river flowing seven times around the underworld, named for Styx, daughter of Oceanus and Tethys, who dwelt in a lofty grotto supported by silver columns at the entrance of Hades. A feminine noun used in apposition, alluding to the exceptionally deep habitat of this species.

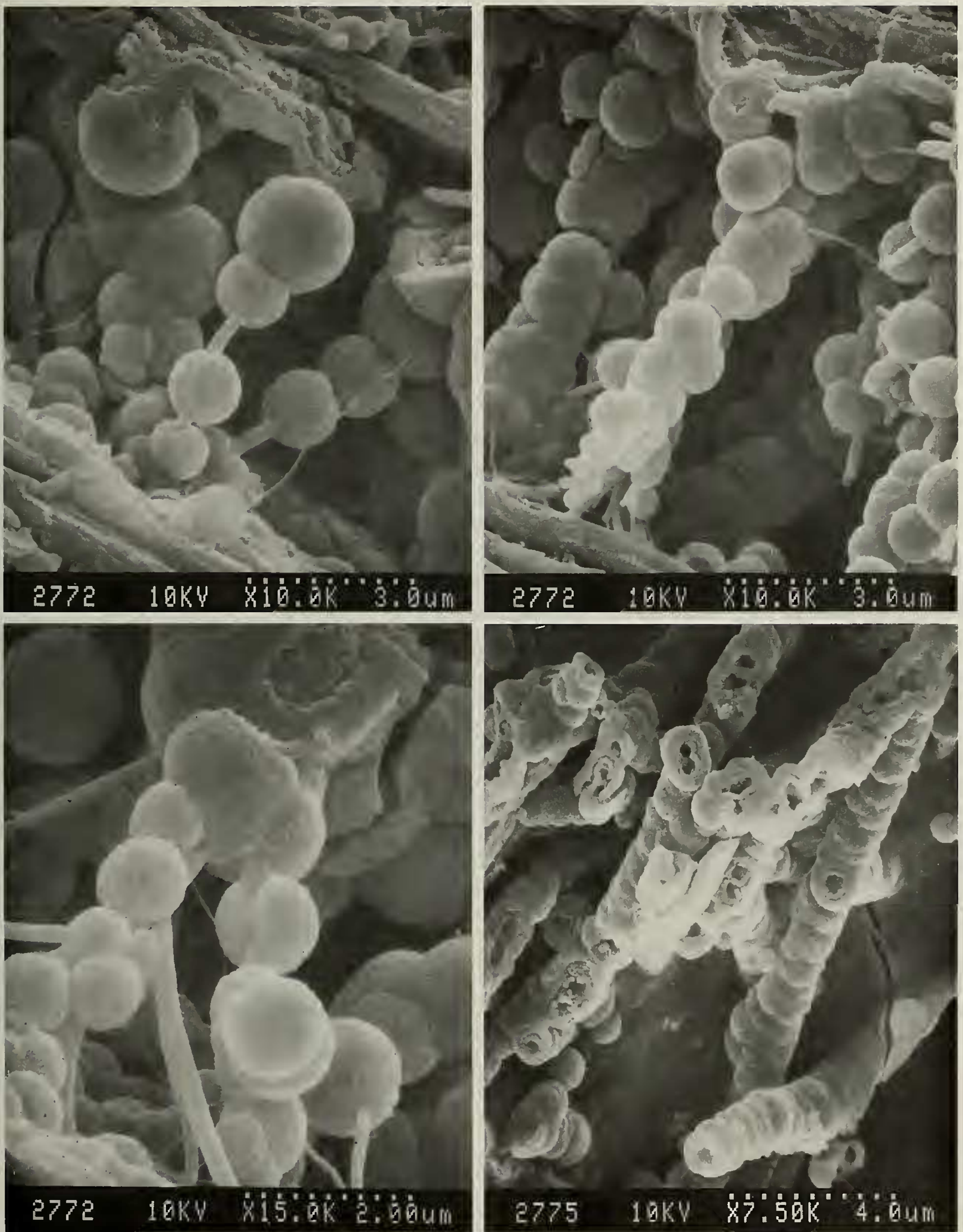

Fig. 5. *Leptogorgia styx*, new species. Mineralized filaments of holdfast loculi. Upper left, Submicron spheres of CHAp on organic filaments show spherulitic microstructure on broken surfaces (SEM 2772); Upper right, submicron spheres of CHAp showing degrees of fusion (SEM 2772); Lower left, Submicron spheres of CHAp on organic filaments show formation of spheres around filament, and microspherulitic structure (SEM 2772); Lower right, Submicron spheres of CHAp coating filaments, fused to form rod-like structures with central lumen originally occupied by organic filament removed by maceration in sodium hypochlorite (SEM 2775).

Remarks.—The flabellate, planar growth form without anastomosis is similar to that of *L. alba* (Duchassaing & Michelotti) and several other species of *Leptogorgia*.

Numerous individuals of a caprellid amphipod were living on this specimen, but so far have not been identified.

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Literature Cited

Chester, W. M. 1913. The structure of the gorgonian coral *Pseudoplexaura crassa* Wright and Studer.—Proceedings of the American Academy of Arts and Sciences 48(20):737–773, pls. 1–4.

Grasshoff, M. 1988. The genus *Leptogorgia* (Octocorallia: Gorgoniidae) in West Africa.—Atlantide Report 14:91–147, including 14 pls.

———. 1992. Die Flachwasser-Gorgonarien von Europa und Westafrika (Cnidaria, Anthozoa).—Courier Forschungsinstitut Senckenberg 149:1–135.

Kingsley, R. J., & N. Watabe. 1982. Ultrastructural investigation of spicule formation in the gorgonian *Leptogorgia virgulata* (Lamarck) (Coelenterata: Gorgonacea).—Cell and Tissue Research 223:325–334.

Koch, G. von. 1878. Mittheilungen über *Gorgonia verrucosa* Pall.—Morphologisches Jahrbuch 4(2): 269–278, pl. 15.

Kölliker, R. A. von. 1865. Icones histiologicae oder Atlas der vergleichenden Gewebelehre. Zweite Abtheilung. Der feinere Bau der hoheren Thiere. Erstes Heft. Die Bindesubstanz der Coelenteraten. [i–iv] + 87–181 pp., pls. 10–19, 13 text figs. Leipzig: Verlag von Wilhelm Engelmann.

Macintyre, I. G., F. M. Bayer, M. A. V. Logan & H. C. W. Skinner. 2000. Possible vestige of early phosphatic biomineralization in gorgonian octocorals.—Geology 28(5):455–458.

Milne Edwards, H. [& J. Haime]. 1857. Histoire naturelle des coralliaires ou polypes proprement dits. Vol. 1. Pp. i–xxxiv + 1–326, 8 pls. numbered A1–6, B1–2. Paris: a la Librairie Encyclopédique de Roret.

Neumann, H. 1911. Untersuchungen über die Bildung des Achsenskelettes einiger Gorgonaceen.—Jenaische Zeitschrift für Naturwissenschaft 47: 497–528, figs. 1–19.

Schimbke, G. O. 1914. Studien zur Anatomie der Gorgonaceen.—Archiv für Naturgeschichte (A)80(11):1–81, pls. 1–4.

Stiasny, G. 1937. Gorgonaria von Cap Blanco, gesammelt durch Dr. Theodore Monod.—Temminckia 2:297–316, pls. 16–17.

Verrill, A. E. 1869. Critical remarks on the halcyonoid polyps with descriptions of new species in the Museum of Yale College, no. 4.—American Journal of Science and Arts (2)48:419–429.

Williams, G. C. 1992. The Alcyonacea of southern Africa. Gorgonian octocorals (Coelenterata, Anthozoa).—Annals of the South African Museum 101(8):181–296.

———, & K. G. Lindo. 1997. A review of the octocorallian genus *Leptogorgia* (Anthozoa: Gorgoniidae) in the Indian Ocean and Subantarctic, with description of a new species and comparisons with related taxa.—Proceedings of the California Academy of Sciences 49(15):499–521.